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XXXVI.—*Anatomical Observations on a new form of Compound Tunicata.* By JOHN DENIS MACDONALD, Assistant Surgeon of H.M.S. 'Herald.'

WHILE cruising in Bass's Strait, two beautiful specimens of a compound Tunicary, whose pyriform zooids exhibited much of the characteristic organization of *Boltenia* and *Cystingea*, were taken in the trawl from a depth of 10–12 fathoms. The zooids, each measuring about half an inch in length, were clustered round the upper or free part of a long cylindrical stem, $\frac{3}{8}$ ths of an inch in diameter; and, as they were all appended to this common peduncle by distinct pedicles, the whole formed an elegant raceme composed of a transparent, colourless, and delicate cartilaginous basis, the equivalent of the test in simple Tunicata.

It will be convenient to describe this interesting form as preserving what we may assume to be its natural position, viz. with the stem erect, the long axis of the zooids more or less horizontal, and the branchial opening turned upwards; it being understood that the latter and the cloacal aperture hold the same relations that obtain in *Boltenia* and *Cystingea*, the branchial orifice being proximal or nearer the pedicle, and the cloacal, distal or subterminal.

The test is smooth externally, and so transparent that its delicate cells are not very readily detected, though the equable distribution of the bright and rounded nuclei is at once apparent. There are no "pallio-vascular"* processes or ramifications in the proper test of the zooids; but a tubular prolongation of the mantle, running through the pedicle of each, connects it with a

* I employ this term for convenience, not being aware that any distinctive name has been given to the structures to which it is applied in the text.

system of tubes, which exhibit in general a longitudinal arrangement in the tissue of the stem (Pl. XI. fig. 2 *q*), and give rise to numerous sacculations spreading peripherically. When this tubular prolongation is cut across, the test may be easily peeled off, as it were, leaving the animal in a fit state for examination.

The external apertures close up in four irregularly puckered folds, but do not exhibit much prominence.

The branchial orifice, which opens upon the upper surface about one-third from the extremity, is furnished internally with a dense circlet of simple subulate tentacula (fig. 6 *e*), whose bases are continuous, on the one hand, with the epithelial membrane of the branchial sac, and, on the other, with that which invests the muscular coat and the viscera, and terminates in the tubular process of the pedicle above noticed.

The muscular tunic is composed of an open work of delicate fibres disposed in different directions, but chiefly running transversely, and the short cylindrical tubes of the external openings are furnished with circular and radiating bundles strongly resembling those of *Boltenia*.

The mouth (Pl. XI. fig. 2 *f*) is situated near the centre of the inferior wall of the respiratory chamber, leading rather suddenly into a lengthy œsophagus (*g*), which, after having reached the extremity of the thorax, opens into a subglobular stomach (*h*) with thick glandular walls tinted with a reddish-brown pigment. This viscus tapers off internally, to form a kind of duodenum coated with amber-coloured cells, which probably fulfil the office of liver.

The intestine here curves upon itself dextrally, and the rectum may be said to course the whole length of the body and terminate close to the cloacal outlet.

A distinct ovarium (*m*) and testis (*o*) are packed together in the loop of intestine, and the delicate vas deferens and a wide oviduct pass outwards side by side between the œsophagus and rectum towards the cloaca.

Ova in the immature state may be seen in the ovarium, cropping out below the duodenum; but a cluster of several, containing tadpole-like embryos in different stages of development, usually occurs in a sacculus of the duct (*n*) below the œsophagus; while others, still further advanced, appear to lie loosely in the branchial sac, quite unconnected with the cloaca.

The heart (*l*), occupying a distinct pericardium, lies immediately above the intestinal loop; and holding a longitudinal position, its alternately reversed vermicular contractions may be easily observed during life.

A well-marked endostyle (*d*) is traceable along the upper or dorsal wall of the respiratory chamber, from the inner side of

the branchial opening to the cardiac end of the stomach, where it suddenly curves downwards and outwards to terminate near the inner side of the mouth. A line drawn through the branchial and cloacal openings would be nearly parallel to this latter portion of the endostyle, and the transverse bars of the branchial network take the same direction. The more delicate longitudinal nervures, on the other hand, are parallel with the first portion of the endostyle, and rather more closely approximated than is usual in other cases.

The nervous system mainly consists of two small rounded ganglia (fig. 6 *b*) lying one upon another, in a right line with, and about midway between, the branchial and cloacal apertures. The deeper one appears to be the larger of the two, and presents a considerable portion of its surface below the other.

It is rather difficult to trace the course of the nerves which radiate from these centres, both on account of the transparency of the nerves themselves and the manner in which the fibres of the muscular coat intersect them. I have been enabled, however, to follow a delicate tubule from the lateral borders of the larger ganglion to a minute black spot composed of a fine granular pigment, lying at some little distance from the median line on either side; and in this observation I am supported by Mr. F. M. Rayner, who inspected the original preparations himself.

Now, the question arises, what is the nature of these spots? they are not confined to this species, for I have distinctly observed their homologues in the zooids of *Sigillina*. Would it be irrational to surmise that they are rudimentary visual organs? which indeed their *primâ facie* appearance would naturally suggest. Analogy, to a certain extent, forbids this conclusion, and several facts tend to show that they are the remnants of the otolithic sacs (fig. 7 *a* and fig. 8, more highly magnified) which exist in the larva in close contact with the nervous ganglia*. I must, however, defer any further remarks on this subject to a future period.

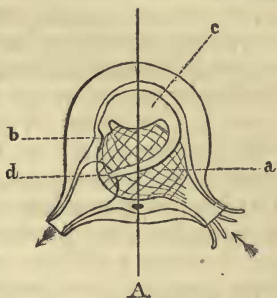
From what has been stated above, it will be seen that the actual relationships of the branchial and cloacal openings, whose position is apparently so anomalous in the present genus, as well as in *Boltenia* and *Cystingea*, do not differ essentially from those which obtain in ordinary Ascidians.

The endostyle, however distorted, must always indicate the dorsal aspect of the animal; hence it would be incorrect to consider the space included between the branchial opening and pedicle, in the genera alluded to, as part of the ventral surface.

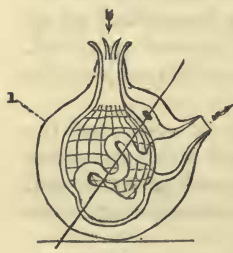
* The disposition of the otolithic sacs in relation to the ganglia tends to show that the axis of the future Tunicary is at right angles to that of its embryo.

This, however, and other particulars, will be better understood by reference to the annexed diagrams, which are principally intended to show the theoretical changes through which a simple Ascidian plan must pass, to assume successively the characters of a common Ascidian, a *Boltenia*, and a zooid of the genus now under consideration, for which I shall adopt the provisional name of *Chondrostachys*.

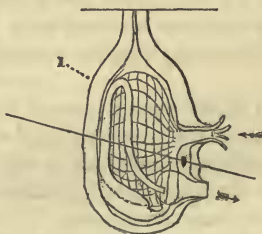
A, simple plan of an Ascidian, with the ventral surface turned downwards. The entering arrow shows the branchial orifice with its tentacula, and the emerging one the cloacal outlet: *a*, the branchial sac; *b*, the mouth and œsophagus; *c*, the stomach; *d*, the intestine and vent; *e*, the cloacal chamber. A vertical line is drawn through the nervous ganglion (indicated by a black spot) and the viscera, dividing the body into an anterior and a posterior half; and the deviation of this axis from that of the plan is represented by a corresponding line in the other diagrams, in which also the several parts marked in the plan will be readily recognized.



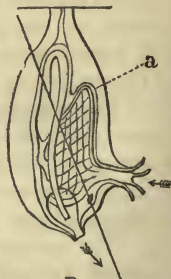
The plan, in the position given, to some extent resembles a zooid of *Pyrosoma*; but if its ventral surface be turned upwards, so that the body may rest principally on the posterior dorsal region, the stomach will then hold a low position; and the intestine, somewhat more lengthened, will naturally take the flexures which it exhibits in the ordinary Ascidian (B).



B



C



D

Let us now suppose this latter form to be suspended from the point 1, B; the body will become elongated, *i.e.* both compressed laterally and depressed in the direction of its vertical axis. The position of the mouth and vent will be lowered, and the loop of

intestine drawn upwards, taking with it the stomach and ovarium. In short, it will have acquired the characters of *Boltenia* (C).

Still further, let the point of suspension be 1, C, and the vertical axis of the body will assume greater obliquity. The endostyle will be bent upon itself (a, D), thus altering the direction of the branchial bars; the mouth, stomach, and intestinal loop will be still more elevated, and the anal aperture more depressed, so that the resulting animal will correspond with one of the zooids of our new genus (D).

The points of difference between the latter and *Boltenia* are given in the following columns:—

Chondrostachys.

Tentacula simple.

Mouth nearly opposite the branchial orifice, widely separated from the vent.

Œsophagus long.

Stomach subglobose, straight, and corresponding with the long axis of the body.

Flexure of intestine dextral.

Rectum anterior.

Length of alimentary canal from the mouth to the flexure one-half less than from the flexure to the vent.

No true liver.

No pallio-vascular canals in the test of the body.

Only the right ovarium, or that included in the intestinal loop, present.

Boltenia.

Tentacula compound.

Mouth near, and rather inferior to the vent, and both approximating the cloacal opening.

Œsophagus short.

Stomach full, elongated, curved, and nearly parallel with the short axis of the body.

Intestinal flexure antero-posterior.

Rectum lateral.

Length of alimentary canal from the mouth to the flexure rather more than from the flexure to the vent.

A well-organized system of hepatic glands.

Minutely ramified and reticulated pallio-vascular canals in the test of both body and stem.

Both right and left ovaria present.

Whoever looks for a veritable affinity here, will certainly be disappointed, though it must be conceded that the general resemblance is quite as close as one might expect the zooids of a representative compound form could bear to such a remarkable though simple Ascidian as *Boltenia**.

* [We venture to think that the true position of *Chondrostachys* is be-

The genus *Cystingea* with its terminal cloacal opening, so far as the disposition of its alimentary canal is concerned, agrees rather with the characters given in the left-hand column; but in nearly all other particulars, as may be gathered from Mr. W. S. Macleay's beautiful description, its affinity to *Boltenia* can scarcely be questioned.

EXPLANATION OF PLATE XI.

Fig. 1. *Chondrostachys*, natural size.

Fig. 2. One of the zooids, with a portion of the axis magnified: *a*, branchial, and *b*, cloacal orifice; *c*, branchial network; *d*, endostyle; *e*, pseudo eye-speck; *f*, mouth; *g*, œsophagus; *h*, stomach; *i*, intestinal loop; *k*, rectum; *l*, heart; *m*, ovarium; *n*, ova occupying a sacculus of the duct (two others are seen in the branchial chamber); *o*, testis; *p*, vas deferens; *q*, pallio-vascular process leading into the stem.

Fig. 3. Transverse section of stem.

Fig. 4. Longitudinal section of the same, on a larger scale.

Fig. 5. Cæcal end of one of the tubules, more highly magnified.

Fig. 6. Ventral surface of a zooid removed and laid out to show the relation of the pseudo eye-specks *a a* to the ganglion *b*; *c*, branchial, and *d*, cloacal aperture; *e*, some of the oral tentacula protruding inferiorly.

Fig. 7. Tadpole-like embryo within the ovum (one of the three suckers, being situated upon the dorsal aspect, does not present itself in this view): *a*, otolithic sacs.

Fig. 8. Enlarged figure of the otolithic sacs lying upon the ganglion: *a*, otolithes separated from the investing pigment-granules.

XXXVII.—On the Affinities of the genus *Camptonyx*, Benson.

By Dr. GRAY, F.R.S. &c.

THERE can be little doubt that this genus is a new form of amphibious mollusk, characterized by its cap-like shell, with a groove and keel on the side; but I think, from the account of the position of the eyes, the shape of the tentacles, and the form of the muzzle, as well as the peculiar colour of the shell, that it is much more nearly allied to *Otina* than to *Ancylus*, with which Mr. Benson compares it.

Otina is nearly as terrestrial; it lives among *Lichina* on rocks near the sea, sometimes within reach of the spray, and more rarely in parts covered by the water at very high tides; but it is essentially terrestrial; and as many plants are common to the sea-shore and mountains, the difference between the habitat of *Otina* and *Camptonyx* is not very great.

tween *Clavelina* and *Syntethys*. The relation of the intestine to the branchial sac in *Chondrostachys* removes it from that group of Ascidians to which *Boltenia* belongs.—Ed.]